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Robotic Vehicle with Hand Motion Control Using a RF Module

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ABSTRACT

This paper focuses on the materials, working principle of a robotic vehicle which will be controlled with hand motion. The aim of this research is to enhance industrialization by creating a hand motion controlled robotic vehicle, since it uses hand motion it will be easier to use in automation and various industries. It is also very beneficial for people with disabilities since only hand motion is required. There were various materials that were used in the research. 2 microcontrollers, an accelerometer, RF modules, encoder, decoder, diode, motor driver IC, DC motor and batteries. The microcontrollers are small computers which can be programmed to be utilized in various different ways. The Accelerometer is a PCB or a sensor which detects speed. The RF modules are of two types which are transmitters and receivers and they are components which are used to send data and information wirelessly. The encoder and decoder are used to convert the binary to any n number of output terminals. The diode is used to send the electricity in one direction. The motor driver IC controls the DC motor from the information given by the microcontroller ICs and lastly a 9v Battery will be used to power the system. The arduino software will be used to program the IC so it can perform the required task. The gadget features a receiver circuit that is intended to be worn on top of the user's glove. The vehicle's circuit incorporates an RF receiver, an 8051 CPU, and a Driver IC to power the motors. This method is extremely useful for persons with impairments since it allows a robotic vehicle to drive itself using hand gestures. The person only needs to move his hand to move the car forward, backward, left, or right. As a result, the user is not required to push any buttons.

Keywords: *Accelerometer, RF Models, RF Transmitter, RF Receiver, PCB, Hand motion control, Microcontroller, DC motors, Arduino, Encoder*.

1. Introduction

1.1. Aim of the Research

The main aim of this research is to enhance the industries by providing hand motion controlled vehicles. This research can be used by individuals who are suffering disabilities or it can be used in workplace which might have hazardous places in which they could use a hand motion controlled vehicle to navigate through the place.

1.2. Introduction to Concept

The concept of this research is the use of hand motion control. That means, this research uses wireless controls to command the vehicle. The RF modules or Radio frequency modules, allow the research to be wireless. The RF modules are of two types, one being the transmitter and the other being the receiver. The RF modules uses radio frequency to transmit and receive the information. To get the detection of the hand motion, the accelerometer is used. It is another important component in this research.

1.3. Introduction to Research

The research is a robotic vehicle which will be controlled with hand gestures. The vehicle's motions, which are handling and control, are determined by the user's gesture. Gesture is captured in this system by an accelerometer which is a device that is attached to a person's hand and measures acceleration. The acceleration is transferred to the microcontroller and encoder circuit. The encoded signal is sent by RF transmitter. The RF receiver component holds down the received signal, which is then decoded and processed by a microcontroller and provides those characteristics to the robotic vehicle so that it can operate actions in accordance with the gesture.

Fig.1. Hand Motion controlled robotic vehicle [1]

1.4. What is hand control?

The capacity to identify and interpret human body gestures in order to interface with and run a computer system without direct physical touch is referred to as hand control [2]-[7]. Because there are no intermediary devices between user and system, these interface approaches are increasingly being referred to as "natural user interfaces."

2. Materials Used

2.1. 8051 series Microcontroller: It is a programmable integrated circuit (IC) that has a small CPU, RAM, and I/O pins. Microcontroller units (MCUs) are widely used in a wide range of devices. It is a 40-pin integrated circuit with dual inline packaging , 128 bytes of RAM, 4kb or ROM, and 16-bit timers. Based on the requirements, It has 4 – parallel 8-bit addressable and programmable ports.

Fig.2. 8051 series Microcontroller

2.2. Atmega 328 Microcontroller: It consists of a small customizable integrated circuit (IC) with a I/O pins CPU and RAM. MCUs are often used in a wide range of devices. It's a 40-pin integrated circuit with dual inline packaging , 128 bytes RAM, 4kb of ROM, and 16-bit timers–2.

Fig.3. Atmega 328 Microcontroller

2.3. Accelerometer: An accelerator resembles a basic circuit for a bigger electrical device. Despite its basic look, the accelerometer is made up of several pieces and operates in a variety of ways, two of which are the piezoelectric effect and the capacitance sensor [8]-[11]. The piezoelectric effect, which employs small crystal formations that get strained owing to accelerative pressures, is the most prevalent type of accelerometer. The tension causes these crystals to generate a voltage, which the accelerometer analyzes to measure velocity and direction. The capacitance accelerometer detects variations in capacitance between adjacent microstructures. If any of these structures is moved by an accelerative force, the capacitance changes, and the accelerometer converts that capacitance to voltage for interpretation.

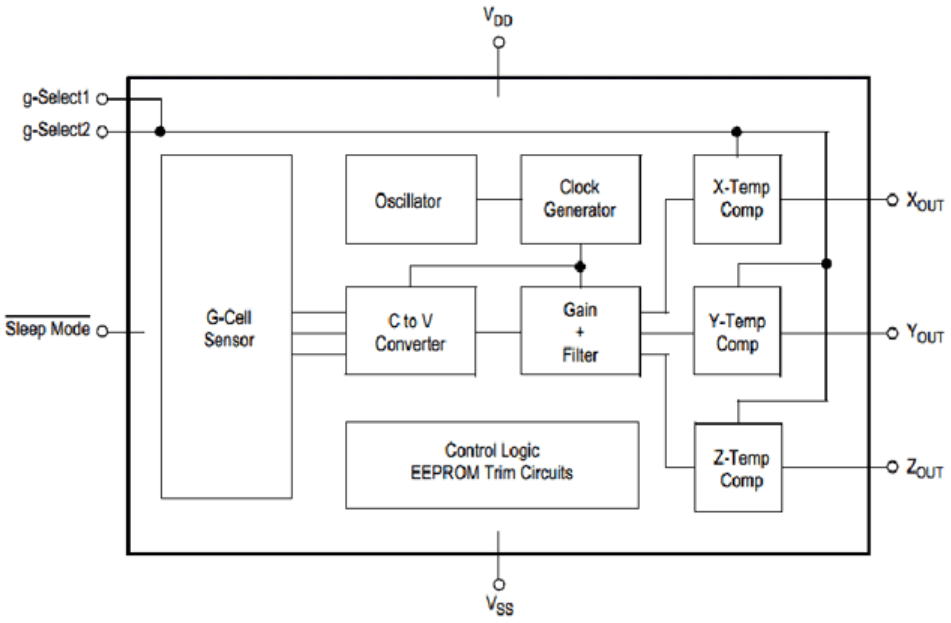

Fig.4. Accelerometer block diagram

Fig.5. Accelerometer

Accelerometers generally have three axis, two for most two-dimensional movement and one for three-dimensional orientation. Most phones use three-axis models, although cars only require two to estimate the point of contact. These devices have a high sensitivity since they are designed to detect even tiny changes in acceleration. An accelerometer's sensitivity determines how quickly it detects acceleration.

Accelerometer Specifications:

Easy to use

Analog output for each axis

+5V operation @ 1mA current

High Sensitivity (800mV/g At 1.5g)

Adjustable Sensitivity (+/- 1.5g, +/-6g)

0g detect for free fall sensing

Rugged construction, strong shock resistance

Low cost

2.4. RF module: An RF module is a small electrical component that allows two devices to send and receive radio waves. It is frequently useful in an embedded system to connect wirelessly with another device.

Fig.6. RF Modules

2.5. RF Transmitter: An RF transmitter module is a tiny PCB sub-assembly that can broadcast a radio wave while modulating it to carry data. Transmitter modules are often implemented in conjunction with a microcontroller, which provides data to the module that may be communicated.

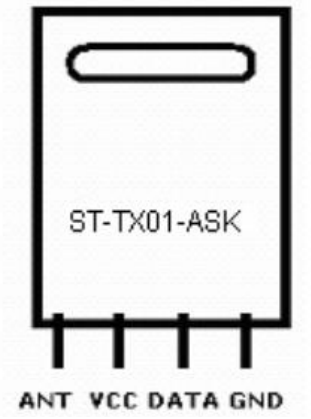

Fig.7. RF Transmitter

RF Transmitter Specifications:

Frequency Range: 315/433.92 MHZ

Supply Voltage: 3~12V

Output Power: 4~16dBm

Circuit Shape: Saw

2.6. RF Receiver: RF Receivers receive a modulated radio frequency signal, demodulate it, and then provide the data to the system for processing.

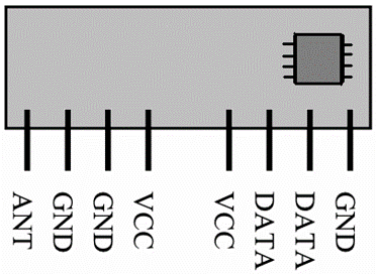

Fig.8. RF Receiver block diagram

RF Receiver Specifications:

Low power consumption

Easy for application

Operation temperature range: -20℃ ~ +70℃

Operation voltage: 5 Volts.

Available frequency at: 315/434 MHz

2.7. RF Encoder: In remote control systems, RF encoders are CMOS LSIs. They can encode data with N address bits and 12 N data bits. Each address/data input has two logic states to choose from. The programmed data are broadcast, together with the header bits, through an RF or infrared transmission channel. When a trigger signal arrives. The ability to pick a TE trigger on the HT12E or a DATA trigger on the HT12A expands the 212 series encoders' capabilities. The HT12A additionally includes a carrier frequency of 38 kHz for infrared systems.

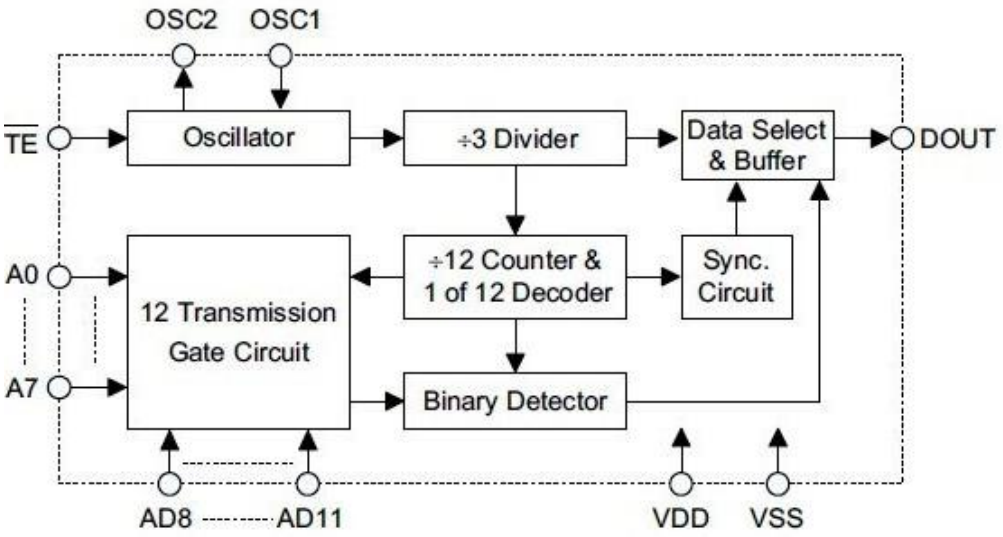

Fig.9. RF Encoder block diagram

RF Encoder Specifications:

The HT12E's operating voltage is 2.4V12V

CMOS technology with low power consumption and good noise immunity

Low standby current (typically 0.1 A) at VDD=5V

HT12A with a carrier frequency of 38kHz for infrared transmission medium

For the HT12E, the minimum transmission words are four words

The built-in oscillator requires only a 5% resistor

The data code is positive polarity

HT12A/E package: 18-pin DIP/20-pin SOP

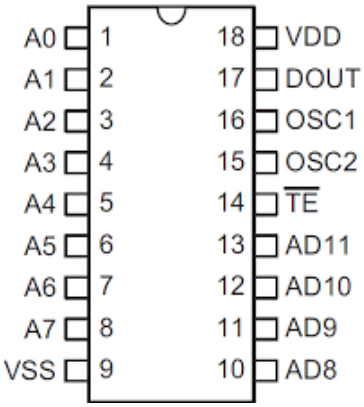

Fig.10. RF Encoder IC Diagram

2.8. RF Decoder: The 212 decoders are a CMOS LSI family designed for use in remote control systems. They are compatible with the Holtek 212 series encoders (see the encoder/decoder cross reference table for further information). A pair of encoder/decoders with the same number of addresses and data format should be used for appropriate functioning. The decoders receive serial addresses and data from a 212 series of encoders through an RF or infrared transmission channel delivered by a carrier. They match the serial input data to their local addresses three times in a row. If there are no errors or mismatched codes, the input data codes are decoded and transmitted to the output pins.

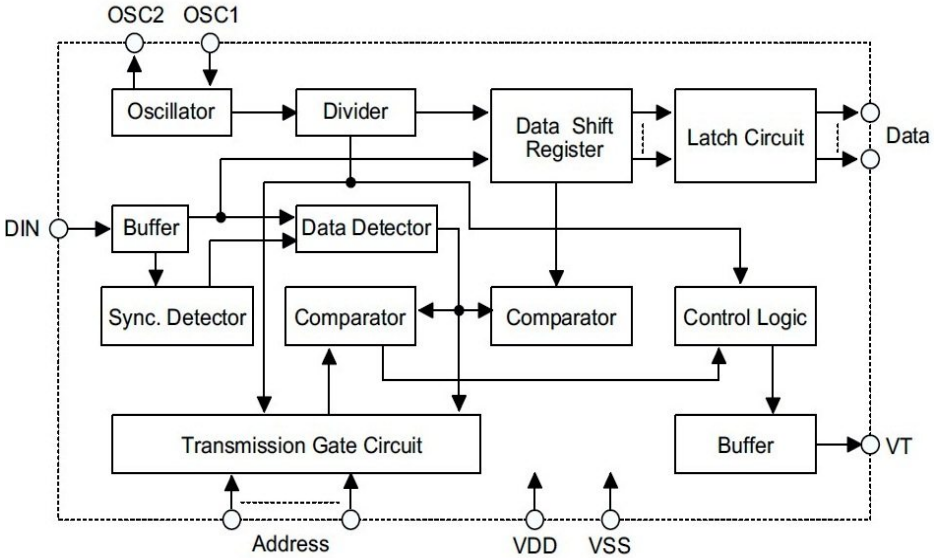

Fig.11. RF Decoder block diagram

RF Decoder Specifications:

Working voltage: 2.4V12V.

CMOS technology with low power consumption and strong noise immunity.

Low standby power consumption.

Capable of decoding 12 bits of data.

Configuration of binary addresses.

Received codes are validated three times.

HT12D address/data number combination: 8 address bits and 4 data bits.

The built-in oscillator requires only a 5% resistor.

Indicator of valid transmission.

Simple connectivity with an RF or infrared transmission medium.

Compatible with Holtek's 212 encoder series.

18-pin DIP, 20-pin SOP package.

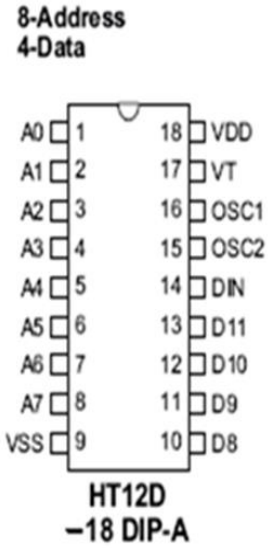

Fig.12. RF Decoder IC diagram

2.9. Diode: A diode is an electrical component that permits electricity to flow in just one direction.

Fig.13. Diode

2.10. Motor driver IC: In robotics, motor driver integrated circuits (ICs) are often used to control DC motors from microcontrollers. They are commonly used in automation since they are critical in controlling the motion of autonomous robots. They can also be found in automobile electronics.

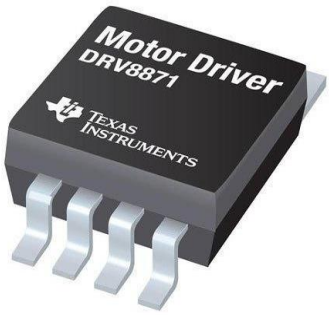

Fig.14. Motor driver IC

Motor driver IC Specifications:

4.5V to 36V supplier voltage range

Separate input-logic power supply

ESD protection on the inside

Thermal failure

Input for High-Noise Immunity

SGS L293 and SGS L293D Functional Replacements

1A output current per channel (600 mA for L293D)

Peak output current per channel is 2 A. (1.2 A for L293D)

Inductive transient suppression output clamp diodes (L293)

2.11. DC motor: A direct current (DC) motor is a type of electrical mechanism that converts electrical into mechanical energy. The input electrical power of a direct current motor is direct current, which is transformed into mechanical revolution [12]-[13].

Fig.15. DC Motor

2.12. Batteries: Battery is a sort of energy source that is made up of one or more electrochemical cells that have terminals on both ends known as an anode (-) and a cathode (+).

3. Working Principle

After the accelerometer recognized the hand movement, the analog data was transferred to the microcontroller on the transmitting side. After processing the accelerometer data, the microcontroller relayed it to the wireless module, which subsequently delivered the signal to the receiver. The microprocessor detects it via the wireless module in the receiving antenna and delivers it to the motors via the motor driver at the receiver end. The wheels subsequently started turning in the direction specified by the hand gesture.

The accelerometer has three axes of motion. The robot is given accurate steering in the X, Y, and Z axes. However, the main goal of the robot was to recognize our hand gestures and utilize them as a medium to control the robot. The Robot moves and behaves in reaction to motions created from a distance by the fingers and hand. As controlled by finger and hand motions, the robot moves up, down, left, or right, picking up items from one position and placing them in another.

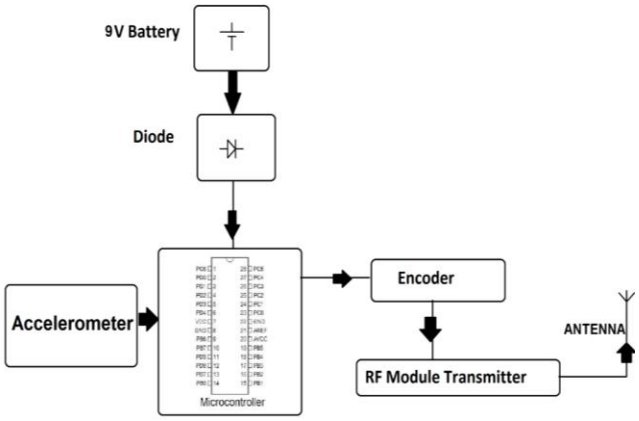

Fig.16. Working of transmitter side

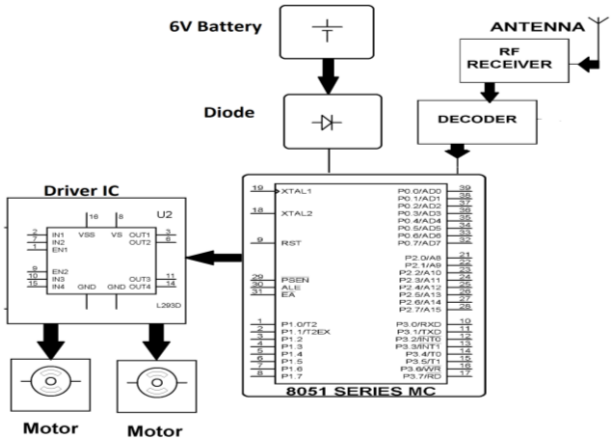

Fig.17. Working of Recover side

4. Explanation in Detail

A hand Controlled robot is one which can be controlled through hand gestures. You only need a little transmitting device and an acceleration meter in your palm to provide an appropriate command to the robot, allowing it to accomplish whatever we desire. An RF transmitter module can generate a radio wave and change it to communicate data. Transmitter modules are frequently employed in combination with a microcontroller, which sends data to the RF module. RF transmitters' maximum allowable transmitter power output is often regulated by regulatory limits. The radar Signal is received and decoded by an RF Receiver module. . The radio receiver translates the transmitter's coded signal to digital format, and the output is available to the microcontroller. The input is provided to the motor driver IC based on the input coded signal, and the robot will react as illustrated below. It Progresses in a forward direction. Moves in the inverse direction. It can even make a left or right turn while moving forward or backward. If a barrier appears, travel backwards, turn left or right, and wait for the next order.

4.1. Applications of Hand motion controlled robotic vehicle

Hand motion controlled robotic vehicles can be very helpful and useful for people who are suffering with some disabilities, as they can move only with the use of the hand motion. For e.g., A wheelchair with a hand motion control. The person has a disability to walk so he/she can use his/her hand movements to control the wheelchair.

4.2. Programming

To program the IC, we have used the arduino software. The Arduino IDE is computer software that allows you to create sketches for numerous Arduino boards. The Arduino programming language is built on Processing, a very basic hardware programming language. The program that we have written is shown below.

```
// variable and pin declarations
int acc_x;
int acc_y:
int DO-9;
int D1-11;
int D2-12;
int D3=13;
void setup()
/setting modes of the pin
pinMode(DO,OUTPUT);
pinMode(D1,OUTPUT)
pinMode(D2,OUTPUT);
pinMode(D3,INPUT);
Serial.begin(9600);
}
void loop(){
acc_x-analogRead(40);
acc_y=analogRead(A1);
if(acc_x<300)
digitalwrite(DO,HIGH);
digitalwrite(D1,LOW);
digitalwrite(D2,LOW);
digitalwrite(D3,LOW);
delay(200);
}
else if(acc_x>400)
digitalwrite(DO,LOW);
digitalwrite(01,HIGH);
digitalwrite(D2,LOW);
digitalwrite(D3,LOW);
delay(200);
}
else if(acc_y<300)
{.
digitalwrite(DO,LOW);
digitalwrite(D1,LOW);
digitalwrite(D2,HIGH);
digitalwrite(D3,LOW);
delay(500);
turn the pin on(HIGH is the voltage level)
turn the pin off(HIGH is the voltage level)
turn the pin off(HIGH is the voltage level)
turn the pin off(HIGH is the voltage level)
wait for a second
turn the pin off(HIGH is the voltage level)
turn the pin on(HIGH is the voltage level)
turn the pin off(HIGH is the voltage level>
turn the pin off(HIGH is the voltage level)
wait for a second
turn the pin off(HIGH is the voltage level)
turn the pin off(HIGH is the voltage level)
turn the pin on(HIGH is the voltage level)
turn the pin off(HIGH is the voltage level)
wait for a second
else if(acc_y>400)
digitalwrite(DO,LOW);
digitalwrite(D1,LOW);
digitalwrite(D2,LOW);
digitalwrite(D3,HIGH);
delay(500);
else
digitalwrite(DO,LOW);
digitalwrite(D1,LOW);
digitalwrite(D2,LOW);
digitalwrite(D3,LOW);
delay(100);
turn the pin off(HIGH is the voltage level)
turn the pin off(HIGH is the voltage level)
turn the pin off(HIGH is the voltage level)
turn the pin on(HIGH is the voltage level)
wait for a second
turn the pin off by making the voltage LOW
turn the pin off by making the voltage LOW
turn the pin off by making the voltage LOW
turn the pin off by making the voltage L
```

5. Results and Discussions

5.1. Result of Assembly of Research

We have successfully made a Robotic vehicle with hand motion control using an RF module.

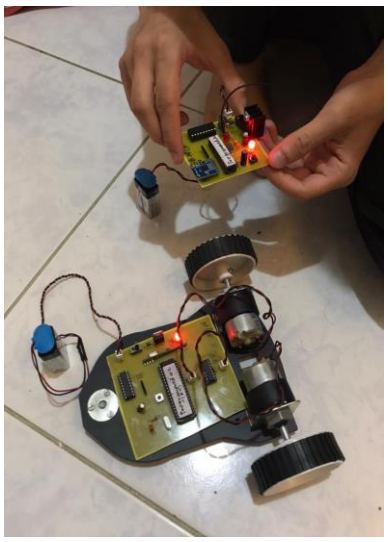

Fig.18. Result of research

5.2. Programming Outcomes

For the vehicle to move forward:

```
if(D1 ==1&& D2 ==0&& D3 ==0&& D4 ==0&& VT=-1)   // condition for fwd
    frwd();
    Delay(200);// Turn the Robot Frwd
```

Fig.19. Vehicle moving forward

The vehicle is successfully moving forward!

For the vehicle to move backwards:

```
if(D1 ==0&& D2 ==1&D3 ==0&& D4 ==0&& VT ==1)    // condition for bck.
    Bkwd();
    Delay(200); // Turn the Robot Backward
```

Fig.20. Vehicle moving backwards

The vehicle is successfully moving backwards!

For the vehicle to move left:

```
if(D1 ==0&& D2 ==0&& D3 ==0&& D4 ==1&& VT ==1)  // condition for left
    Left();
    Delay(200); // Turn the robot Left
```

Fig.21. Vehicle moving left

The vehicle is successfully moving left!

For the vehicle to move right:

```
if(D1 ==0&& D2 ==0&& D3 ==1&& D4 ==0&& VT ==1)// condition for right
    Right();
    Delay(200); // Turn the robot right
```

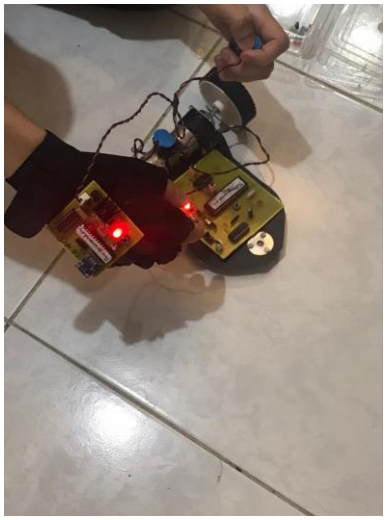

Fig.22. Vehicle moving right

The vehicle is successfully moving right!

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Declarations

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Competing Interests Statement

The authors declare no competing financial, professional and personal interests.

Consent for publication

Authors declare that they consented for the publication of this research work.

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